Work Plan to Implement Pilot River Bank Stabilization Projects on the Tittabawassee River

Prepared for:

The Dow Chemical Company
Midland, MI

Prepared by:

ENVIRON International Corporation
Chicago, IL

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Acronyms and Abbreviations

BEHI	Bank erosion hazard index
CSM	Conceptual site model
ENVIRON	ENVIRON International Corporation
GPS	Global positioning system
IRA	Interim removal action
License	Hazardous Waste Management Facility Operating License
MDEQ	Michigan Department of Environmental Quality
Midland Plant	Michigan Operations-Midland Plant
RBS	River bank stabilization
RBSWP	River bank stabilization work plan
TEQ	Toxicity equivalency
UTR	Upper Tittabawassee River

1 INTRODUCTION

This *Work Plan to Implement Pilot River Bank Stabilization Projects on the Tittabawassee River* has been prepared on behalf of The Dow Chemical Company (Dow) by ENVIRON International Corporation (ENVIRON) and LimnoTech Inc. (LTI), in consultation with Ann Arbor Technical Services, Inc. (ATS). This River Bank Stabilization Work Plan (RBSWP) has been prepared to provide the basis of a Tittabawassee River RIWP Feasibility Pilot Study and pursuant to Condition XI.B.5of the 2003 Hazardous Waste Management Facility Operating License (License) issued by the State of Michigan Department of Environmental Quality (MDEQ) for addressing corrective actions beyond the boundary of Dow's Michigan Operations-Midland Plant located in Midland, Michigan (Midland Plant). The work described herein is consistent with the January 2005 Framework for an Agreement between the State of Michigan and Dow for addressing concerns regarding the Tittabawassee River. This work plan outlines the approach to identifying potential pilot project areas and the proposed process for implementation of river bank stabilization (RBS) technologies at those areas.

1.1 Objective/Purpose of Work

This work plan proposes the selection of areas along the Tittabawassee River between the Dow Dam and the confluence with the Shiawassee River where RBS pilot projects will be implemented and monitored. The implementation of RBS pilot project work in selected areas will be prioritized such that work can commence in 2008. The goals of the RBS pilot projects are to:

1. Implement – after careful engineering review of different available RBS technologies – the most promising technologies that offer the best opportunities to control, to the extent necessary, active erosion and/or to reduce the potential for future erosion of soil from existing river banks at locations on the Tittabawassee River with elevated furan and dioxin toxicity equivalency (TEQ) levels.
2. Evaluate the effectiveness of different RBS technologies for providing long-term river bank stabilization along the Tittabawassee River. Monitoring before and after the implementation of selected RBS technologies will be necessary to achieve both goals.
3. Develop protocol for monitoring River Banks with a range of erosion indicators to evaluate techniques for evaluating and measuring erosion.

1.2 Report Organization

This *RBSWP* is organized as follows. The introduction (Section 1.0) is followed by an overview of the Study Area and a summary of the approach used to select river bank areas to pilot stability technologies (Section 2.0). Section 3.0 introduces the implementation approach and design criteria for bank stability technology selection. The project schedule is presented in Section 4.

2 SELECTION OF RIVER BANK LOCATIONS FOR PILOT STABILIZATION

The implementation of RBS pilot technologies on the Tittabawassee River requires the identification and selection of appropriate river bank locations. This section describes the approach used to select suitable locations for RBS pilot studies. Figure 1 illustrates the factors considered in the selection of potential pilot project areas. These factors included property ownership, measured toxicity equivalency (TEQ) levels in the river banks, bank erosion hazard index (BEHI) screening values, construction access, and other considerations such as prioritizing upstream locations, and selecting areas where different approaches can be implemented and monitored.

2.1.1 Ownership/ Property Access

Priority was given to river banks located on property owned by Dow along the upper Tittabawassee River (UTR). Working on Dow property reduces, and in some cases eliminates, area ownership and access issues for sampling and construction work.

2.1.2 TEQ and BEHI Screening Values

Primary drivers for identifying candidate project areas are furan and dioxin TEQ levels in river banks and levees along the UTR, as reported by ATS (2008) and corresponding BEHI screening values, which characterized river bank conditions in 2007, as reported by ENVIRON and LTI (ENVIRON and LimnoTech, 2008).

As part of the BEHI screening activity, data on current river bank conditions were collected at locations spaced 400-feet apart along the Tittabawassee River, extending from the Chippewa River confluence southward to the confluence with the Shiawassee River (ENVIRON and LimnoTech, 2008). Evidence and potential causes of erosion or stability were documented at each survey location, along with data on physical characteristics, vegetation, and other surface cover. The data gathered in the survey were used to develop BEHI screening values, which provide a quantitative screening-level assessment of the relative stability or potential for erosion of each surveyed location (also described in Rosgen 2001; EPA 2007). As reported in ENVIRON and LimnoTech (2008), river bank BEHI screening values generally segregated into three categories:

- BEHI screening value (0 – 8); river banks were determined to be stable, well vegetated or armored against high-energy forces that might cause erosion.
- BEHI screening value (8 – 10); river banks were determined to be stable, but less well vegetated and with little or no armoring against high-energy forces that might cause erosion.
- BEHI screening value (>11); river banks were determined to be potentially unstable, and unlikely to withstand erosion forces during high-energy events.

In addition to the bank stability scoring, a continuous video/global positioning system (GPS) survey of the river banks of the Tittabawassee River was completed, extending from the confluence with the Chippewa River in Midland southward to the confluence with the Shiawassee River (ENVIRON and LimnoTech 2008). The video/GPS survey was used as a tool to review the current (fall 2007) status of river bank conditions at candidate pilot project areas. The video survey provides a spatially continuous record of river bank conditions that can be used to compare against future river bank conditions. The

video survey also provides a readily accessible means to compare and contrast BEHI screening values along the river, and review important factors such as accessibility, obstructions or debris at candidate project areas.

Using the data reported by ATS (2008), TEQ levels were considered in terms of both the presence of elevated levels (i.e., levels >1,000 ppt) in river banks and near-bank areas, and in terms of the potential degree of exposure where elevated levels were observed. Elevated TEQ levels in buried river bank soils (i.e., depths >1 foot) that are stable (i.e., resistant to erosion during high-energy river flow, winter storm, and similar events) and are otherwise inaccessible to human and ecological receptors pose little or no immediate risk of exposure. ATS (2008) reported that TEQ levels in soil along the majority of Tittabawassee River banks and natural levees are buried beneath soil containing significantly lower TEQ levels (often less than 500 ppt). Consequently, the presence of elevated TEQ alone is not sufficient to guide selection of pilot project areas.

An additional factor for selecting pilot project locations was consideration of river bank locations where the exposed face of the river bank would contain elevated buried TEQ. Locations were identified, in part, using the results of horizontal cores (erosion scar samples) collected from river banks by ATS in 2007 (ATS 2008). These data were considered as a third screening tool to identify pilot project locations.

In summary, several lines of evidence – TEQ levels, BEHI screening values, video GIS survey, and erosion scar sampling – were considered together as screening tools to identify candidate river bank stabilization pilot project areas within the areas that provided access. Candidate areas identified for consideration fell into three primary categories:

1. BEHI screening value >11 / elevated TEQ (> 1,000 ppt),
2. BEHI screening value >11 / elevated TEQ (>10,000)
3. BEHI screening value <8 / elevated TEQ (>1,000)

2.1.3 Construction Access for River Bank Pilot Projects

The degree of construction access to specific river bank areas along the Tittabawassee River was evaluated. Existing access infrastructure to the river bank allows for deployment of heavy equipment and minimizes disruption of other potentially stable floodplain and riverbank areas. Physical road access was evaluated through local knowledge, mapping and review of aerial photographs.

2.1.4 Candidate River Bank Areas Targeted for Monitoring Only

Candidate areas for monitoring only included river banks with high TEQ and relatively low BEHI screening values, or low TEQ and relatively high BEHI screening values. These candidate areas were identified to evaluate a range of monitoring approaches useful for tracking long-term river bank stability and natural changes to river bank conditions over time.

2.2 Selection of Candidate RBS Pilot Project Locations

In order to identify potential locations for pilot bank stabilization projects, maps were developed for the upper reaches of the Tittabawassee River showing land ownership, TEQ results, and BEHI screening values (Figures 2a through 2e). Mapped TEQ and BEHI screening values were used to identify areas

with characteristics of interest for work. Continuous (800 feet or greater) zones were coded using the following characteristics:

BEHI screening value 11 or greater / TEQ 1,000 or greater:	Orange
BEHI screening value 11 or greater / At least one location with TEQ 10,000 or greater:	Red
BEHI screening value less than 8 / TEQ 1,000 or greater:	Green
BEHI screening value 11 or greater / unknown TEQ level:	Blue

In addition, several reaches with low or intermediate BEHI screening values were identified as potential monitoring locations where a protocol to monitor current and future river bank condition could be implemented.

After the initial screening, six candidate pilot project areas were identified using the criteria in section 2.1 and the map coding described above. Table 1 lists the candidate areas and their key characteristics. The table identifies two areas along Reach M, one area along Reach O, and one area along Reach P as possible pilot project areas. Each area meets the primary requirements set forth in the screening process. In addition, river banks in reaches P and Q were identified as candidate areas for monitoring of bank stability. Of the candidate areas presented in Table 1, reaches M and O provide the conditions best suited for the RBS pilot project in terms of accessibility, BEHI screening values and TEQ conditions, and representativeness of Tittabawassee River characteristics. The area identified in Reach P is relatively short and at the mouth of a drain that creates a unique condition less representative of the river compared to Reaches M and O.

Based on review of the available mapped and video data, the following river bank locations are proposed for the 2008 RBS pilot project:

Construction & Monitoring

- Upper Reach M –BEHI screening value >11, steep bank conditions, and elevated TEQs.
- Lower Reach M –BEHI screening value 8 – 10, bank slope of <45 degree (lower than Upper Reach M), and elevated TEQs.
- Reach O – continuation of the monitoring of three river banks that were re-constructed after the completion of the July – November 2007 Reach O removal activities. As part of the early monitoring review, additional work may include further construction work to stabilize areas between the three re-constructed river bank areas.

Monitoring Only

- Reach Q – monitoring an area with elevated TEQs and moderate BEHI screening value.
- Reach N – monitoring along the southwest riverbank area (i.e., reach sections 300+00 – 304+00) with elevated TEQs and elevated BEHI screening value. This area was the focus of initial point cloud imaging surveys conducted in January 2008, as reported in ENVIRON and LimnoTech (2008).

Table 1: List of Potential River Bank Stabilization Pilot Project Areas for Comparison.

Location	Description	Measured TEQs >1,000	BEHI screening value range	Road/ Equipment Access	Length
Pilot River Bank Stabilization Construction & Monitoring Areas					
Reach M (273+00 to 277+00)	Bank characterized by extensive exposed tree roots and very steep bank angle	6,400-17,000 *Erosion scar sampling results available*	12.5-13	Good, next to boat ramp	~500'
Reach M (277+00 to 280+00)	Bank characterized by extensive exposed tree roots and shallower bank angle	17,000- 30,000 *Erosion scar sampling results available*	8-13	Very Good	~500'
Reach O (~323+00 to 333+00)	Some eroding areas near previous removal area, small eroding area downstream of removal	44,000 -25,000 (prior to 2007 removal) ~5,000 downstream of previous removal	11	Very Good	intermittent
Reach P (347+00 to 353+00)	Undercutting and overhanging vegetation near mouth of tributary/ drain	20,000	13	Good	<400'
Pilot River Bank Stabilization Monitoring Only Areas					
Reach N (300+00 – 304+00)	Elevated BEHI area in middle part of reach (south shoreline)	9,000	12-13	Good	~ 400'
Reach P	Low BEHI area in upper portion of reach with high TEQ	35,000	4-5	Good	~ 400'
Reach Q	Moderate BEHI throughout reach – variable erosion	5,000 – 10,000	8-10	Fair	1600'

This table only reports TEQs >1,000 ppt. Samples below 1,000 ppt also were reported to occur in the riverbank and levee soils, particularly in surface soils (see ATS 2008).

3 PROJECT IMPLEMENTATION

Consideration of any RBS technique requires identification of the processes that contribute to potential bank erosion, erosion variability, cost, the applicability of potential techniques, and project goals that extend beyond stabilization. RBS techniques range from active highly engineered solutions (e.g., rip rap and sheet pile bulkheads) to softer and less intrusive techniques (e.g., planting grasses, shrubs, and trees that stabilize the banks, and use of vanes, snags and similar river energy management elements). When possible, the desired project goals that will influence the selection, design, and implementation of the pilot study techniques include creating a relatively "natural" and aesthetically pleasing environment, minimizing heavy construction techniques to the extent possible, creating a habitat that provides ecological value to the watershed, and selecting techniques with low maintenance requirements. The impacts of the bank stabilization design on other hydrodynamic conditions in the river must also be considered.

3.1 Characterize Current Condition

The design process will include further characterization of current conditions at each pilot project location. These are some of the conditions that may be measured and reported:

- Geotechnical data
- Bank slope
- Soil properties
- Local velocities and corresponding shear stress
- Existing vegetation
- Site-specific factors that contribute to erosion.

The results of the characterization work will also be used to identify and select the appropriate RBS technologies and their design.

3.2 Permitting

As the stabilization designs and details are completed and to the extent that permits are required for this work, Dow will submit the requisite permits before implementing RBS pilot work.

3.3 Design

The first step in the design sequence will be to identify one or more of the specific goals intended for the specific stabilization outcome at each project area. River bank stabilization technologies (or combinations of technologies) will then be identified to be screened for potential implementation at each pilot project area. The technologies will be evaluated for their effectiveness and applicability to meet the goals according to location and specific bank characteristics such as:

- Accessibility for necessary equipment
- Hydrodynamics of the area (flow velocity and expected sheer stresses)
- Bank configuration (bank slope, width and height)

- Condition of existing vegetation (including root depth and density) and the identification of existing undesirable vegetation species that may be negatively impacting river bank stability (i.e., vegetation that may exacerbate erosion)
- Soil type
- River morphology and the potential long-term impacts of bank stabilization on morphology

Following the selection of a technology for a given pilot project area, a detailed design will be developed. The design may include a range or possible combinations of RBS technologies.

Concurrent with the detailed design, prospective contractors will be screened for experience and capabilities specific to the selected technologies. Prior to completing the design, a constructability review will be conducted with prospective contractors to evaluate the implementability of the design, including any limitations that may be imposed on the construction of a pilot project, such as limiting the extent to which soils are removed (if at all), defining area access conditions to accommodate – to the extent possible – the existing ecology, or specifying planting seasons.

3.4 Develop a Monitoring Plan

A monitoring plan will be developed that identifies monitoring techniques, frequency, and duration. The monitoring plan also will identify contingencies and maintenance requirements, as needed and as appropriate to the selected RBS techniques. The plan will include the following components:

1) Document current condition including physical bank configuration, estimated bank entrainment rates, and vegetative cover (species, root depth, and corresponding vegetation and root densities).
2) Document post-construction as-built stabilization measures, physical configuration and vegetative plantings.
3) Establish a monitoring schedule and goals for plant survival and vegetative cover over time (including describing desired community – trees, shrubs, native species, invasive species, etc.).
4) Identify contingencies and maintenance requirements, as needed and as appropriate to the selected RBS techniques.

4 PROJECT SCHEDULE

The following schedule is anticipated for the completion of the RBS feasibility pilot studies. MDEQ approval of the RBS work plan and design documents is assumed to require not more than 7 to 15 days. The schedule is contingent upon receiving written approvals from MDEQ to proceed with work.

Table 2: Proposed Project Schedule

	Task	Start Date	Approximate Completion Date
1	Submit Work Plan to MDEQ for Review and Approval	---	June 16, 2008
2	MDEQ Approval of Work Plan	---	June 23, 2008
3	Identify Companies with Relevant Expertise to Assist with RBS design	June 2, 2008	July 1,2008
4	Compile Available Environmental Data & Conduct Physical Characterization to Fill Data Gaps at Pilot Project Areas	June 17, 2008	July 15, 2008
5	Develop and submit for review an approval Detailed Design of Monitoring Only Work at Designated Pilot Project Areas	July 1, 2008	August 1, 2008
6	Develop and submit for review and approval Detailed Design of Construction & Monitoring Work at Designated Pilot Project Areas	July 1, 2008	August 1, 2008
7	Contractor selection for construction of Pilot Project Areas	---	August 1, 2008
8	MDEQ Approval of Detailed Design Plans	---	August 7, 2008
9	Permitting		August 8, 2008
10	Mobilization to Implement Construction Work	Based on obtaining required permits	December 1, 2008
11	Mobilization to Implement Monitoring Only Work	August 2008	On-going schedule TBD

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Figures